Section 4
Conservation Program, Water Right Analysis, System Reliability, and Interties

This Section of the 2001 Water System Plan (WSP) addresses a number of related topics. Section 4.1 describes Seattle Public Utilities' (SPU) conservation program. Section 4.2 provides an analysis of the potential new sources of supply. Section 4.3, summarizes water rights held by SPU. Section 4.4 provides an overview of system reliability. Finally, Section 4.5 identifies interties that link SPU's water system with other public water systems.

4.1 1999 Conservation Program

Over the past 20 years, population served has grown by 25% but total consumption was actually reduced as a result of conservation efforts.

Making more efficient use of existing water resources through conservation is an economical and environmentally responsible way to accommodate competing demands for drinking water to meet long term population growth and at the same time protect instream flows needed for fish. Since 1980, the population served by SPU and its 27 wholesale purveyors has grown by almost 25 percent--yet water consumption in 1999 was actually lower than in 1980, thanks to conservation programs and the response by customers. The SPU report, Regional Water Conservation Accomplishments 1990-98 (SPU, 1998b) provides detail on how these savings were achieved. Regional survey data show that over 90 percent of customers believe conservation is important. This Section outlines SPU's strategy for continuing to develop conservation as a proven water resource. In addition to what is contained here, SPU compiles the data, plans and methodology descriptions required by the current DOH/DOE Conservation Planning Requirements for data collection, demand forecasting and conservation planning.

4.1.1 Overview

The 1993 WSP and the 1996 Long Range Regional Water Conservation Plan (Long Range Plan)(Appendix 4-A) presented a vision and plan for the 1990s and beyond. The programs laid out in those earlier plans are now approaching maturity, and were originally scheduled to begin phasing out after 2000. However, SPU and its purveyor partners are now launching a new effort to achieve additional conservation savings through the first decade of the new century.

In 1998, SPU completed a Water Conservation Potential Assessment (CPA) (Appendix 4-B), which provided a rigorous analysis and evaluation of conservation opportunities available for SPU's wholesale and retail

customers. The CPA found that savings of more than 24 million gallons per day can be achieved at a cost less than the cost of new water supply.

SPU has adopted a new conservation initiative to tap the first 18 MGD of the potential savings from conservation identified in the CPA by 2010. SPU and its purveyor partners have begun a ten year program that is designed to reduce regional per capita water use by 1 percent per year – enough savings to maintain total consumption at or below current levels while accommodating expected growth in regional population and business. This approach is called the "1% Conservation Program," and was committed to as part of the Cedar River Watershed Habitat Conservation Plan (HCP). The initiative consists of conservation programs identified in the CPA.

The "1% Conservation Program" will continue to reduce per capita consumption.

The 1% Conservation Program is currently being developed using the CPA as the basis for the program. The Long Range Plan and the CPA provide the details of conservation activities' cost, performance, and implementation efforts. The budget and projected savings of the 1% Conservation Program are shown in Tables 4-1 and 4-2a.

Table 4-1
1% Conservation Program Budget

Years:	1999-2010
Marketing, Education, Administration, Evaluation	$10,000,000
Incentives and Other Direct Expenditures	$45,000,000
Total Expenditures	$55,000,000

Table 4-2a
1% Conservation Program Water Savings by Type of Use (MGD)

Type of Water Use	Savings 2010
Domestic	10
Landscape	4
Commercial, Industrial and Institutional Process	4
Total	18

The early years of the program will consist primarily of expansion of existing programs and plans outlined in the Long-Range Plan. The later years will involve development of new efforts identified in the CPA. These new efforts will be implemented in succeeding years of the 1% Conservation Program.

Further information on historical conservation savings and the incorporation of future savings into SPU planning is given in Section 2 of this WSP.

4.1.2 Conservation Principles

Conservation is one of the ways SPU is trying to effectively manage its water resources to meet the needs of both people and fish. As discussed in the 1993 Water Supply Plan, the conservation program cost will be no greater than the cost avoided by elimination, or postponement, of the need for new, conventional water supply. Conservation measures identified in the CPA which meet the test of cost-effectiveness will be implemented under SPU's conservation program. The CPA contains the cost-effectiveness analysis for each measure.

Conservation efforts require a team effort among SPU, purveyors, and customers.

Conservation programs will be achieved on a collaborative basis among SPU, purveyors, and customers. Although the responsibility for planning and delivering regional conservation programs currently resides with SPU as the regional provider, the involvement and support of all participants, especially purveyors has been, and will continue, to be critical. Conservation programs are customer driven - they need to be tailored to the customer's needs and motivations to be effective.

SPU's Conservation principles include:

- Working collaboratively with wholesale customers and other regional partners;
- Focusing on programs that reduce demand during the summer;
- Ensuring equity among ratepayers by offering programs for residential and nonresidential customers and promoting customer cost sharing;
- Making the greatest impact by concentrating program resources;
- Reducing costs or providing additional benefits by seeking partnerships and avoiding lost opportunities;
- Ensuring program success by monitoring and evaluating program savings and costs; and
- Testing program design with pilot efforts prior to full-scale program implementation.

4.1.3 Strategies and Measures

SPU Conservation measures are grouped by five strategies:

- Water rate structures
- Codes and regulations
- Water supply system efficiency
- Customer incentives
- Public information and education.

In addition, conservation programs are designed based on how the water is used. Water use by customers can be divided into three categories: 1) Domestic – drinking, cooking, cleaning, and sanitary use; 2) Landscape – lawn and garden irrigation by businesses, parks, golf courses, and homes; and, 3) Process – cooling, heating, manufacturing, and product use. Finally, water used for water supply system operation itself, such as line flushing and water lost through leaks, evaporation, and other causes is termed non-revenue water.

SPU is pursuing all the avenues of conservation discussed below. In some cases, the programs are fully mature and have already achieved significant savings. In other cases SPU is just beginning to implement new programs or may still be in the research and development phase. For specific savings targets, refer to the Long Range Plan and CPA included in Appendices 4-A and 4-B.

Water rates are structured to encourage conservation.

Rate Structures. Structuring water rates to encourage conservation is a key conservation strategy and gives customers more control over their water bills. SPU has had good success in encouraging water use efficiency, especially during the summer peak, with its seasonal rate structure. Generally, the more water costs per amount used, the less customers will use. SPU uses summer rates, and many purveyors use seasonal or inclining block rates, to encourage water conservation. Table 4-2b shows SPU's retail customer water rates for 2000-2001. The higher commodity rates in the summer help encourage water use efficiency when demand is greatest. To support this, consumption histories are provided on customer bills. Seattle, and some of its partnering purveyors also have consumption-based sewer rates that encourage customers to conserve. SPU is researching the possibility of submetering individual apartment units to give tenants a price incentive for conservation.

Monthly billing was also suggested during the development of the CPA. Currently, there are no available empirical data quantifying the expected savings from changing to monthly from bi-monthly billing. A cost-benefit analysis undertaken during a previous rate study (using reasonable assumptions on potential conservation savings) indicated it was not cost-effective. However, as the costs and benefits change, and as empirical evidence of its efficacy is obtained, more frequent billing may become cost-effective. SPU will be updating its CPA in 2003 and thereafter every five years. During these updates, SPU will review and identify cost-effective conservation program delivery tools, such as monthly billing, for inclusion in continuing conservation efforts.

Table 4-2b
SPU's 2000-01 Residential Commodity Charge
($/100 Cubic Feet)

	Inside Seattle	Outside Seattle
Off-Peak Usage (Sept. 16th - May 15th)	$2.16	$2.46
Peak Usage* (May 16th - Sept. 15th)	$2.53	$2.88
2000-01 Commercial Commodity Charge ($/100 Cubic Feet)		
Off-Peak Usage (Sept. 16 - May 15th)	$1.11	$1.27
Peak Usage (May 16th - Sept. 15th)	$2.01	$2.29

(*All use over 5 ccf per month)

Codes and Regulations. A highly effective conservation strategy is to adopt codes and ordinances that require certain efficiency levels, or prohibit certain kinds of water waste. Expected savings from codes are incorporated into SPU's conservation plans and demand forecasts.

The Plumbing Code Efficiency Standards at the state and federal level require low volume bathroom fixtures. Savings from these standards are currently included in forecasts, although the standards may be repealed by Congress. The Energy Policy and Conservation Act requires the U.S. Department of Energy to develop efficiency standards for washing machines and dishwashers. Since they are not expected to be developed soon, potential savings are not being counted. Locally, King County has a landscape code that promotes water efficiency, and Bellevue has water efficiency requirements for new commercial landscaping, as does Seattle where commercial landscaping is required.

Public information and education form the backbone of conservation programs.

Public Information and Education. Public information and education programs are the backbone of an effective conservation program, to inform customers both why they should conserve and what conservation programs are available to them. Ongoing promotion and marketing efforts by SPU include brochures, public service announcements, paid advertising, newspaper articles, presentations, talk shows, trade fairs, etc. These activities promote awareness of environmental impacts of water usage, and encourage customers to use water more efficiently. The "Summer Campaign" promotes conservation during the summer, particularly outdoors. There are other efforts as well, such as the Residential Efficient Toilet Promotion, "Green Business Recognition," point-of-purchase promotion for water efficient irrigation products, a demonstration garden installed at the University of Washington Center for Urban Horticulture, school programs, and promotion of water use efficiency in apartments and condominiums. These programs are described further in the Long Range Plan and CPA (Appendices 4-A and 4-B).

Incentives. Providing customers financial incentives to convert to a more water efficient fixture, technology, or behavior is a necessary strategy to overcome the many barriers that sometimes prevent customers from taking actions on their own. Incentives take a variety of forms including rebates, technical assistance, low interest loans or even "give-aways" of conservation products. Incentive programs undergo rigorous analysis before being implemented.

Rebate programs encourage customers to replace old fixtures with new more efficient ones.

Rebate programs encourage customers to replace old high-use fixtures with new more efficient ones. Rebate programs that SPU will continue to conduct include: single-family toilet retrofits, commercial toilet retrofits, and wash-wise/high-efficiency clothes washing machines.

Technical assistance and financial incentives are available to commercial irrigators through the Water Efficient Irrigation program. Commercial, industrial and institutional customers can get assistance and financial incentives for process conservation measures. Single family customers with high water use due to irrigation can also get assistance. Finally, use of treated effluent to provide industrial process and cooling water will continue to be explored.

System Efficiency. Water lost to leaks, unnecessary reservoir overflows, or inefficient water main flushing is wasted. Further, inaccurate meters can under-record actual water use. Reducing non-revenue water to acceptable levels is a key strategy and signals to the public that SPU is "keeping its own house in order." For more detail see Section 2.

4.1.4 Research and Development

Promising new water-efficient technologies and conservation programs will emerge over time. Researching and testing them through demonstration and pilot programs produces new options for future conservation programs and can accelerate changes in the market place as interest in water-efficient technologies increases. Assumptions regarding savings and costs are refined based on field testing of technologies with actual customer experience.

4.2 Source of Supply Analysis

The purpose of the source of supply analysis is to determine opportunities for optimizing the use of sources already developed, to evaluate innovative methods for meeting water needs, and to identify new sources particularly those requiring new or additional water rights. The Department of Health (DOH) requires that purveyors perform this analysis if additional water rights are needed within the next 20 years to meet system demands. SPU does not anticipate needing new water rights in that time period. However, the source of supply analysis is included in this WSP to support SPU's

parallel planning policy, which directs the utility to plan for possible changes in technology, regulations, or information.

Firm yield of SPU's system (based on 98% reliability) is shown in Table 4-3. This table includes the firm yield for the existing system with and without the new Tolt Treatment Facility, and participation in Tacoma's Second Supply Project (SSP).

Table 4-3
Firm Yield of Seattle Public Utilities' Supply Sources

Supply System	Firm Yield
Existing System with Cedar River, South Fork Tolt River, Highline Wellfield, and Requirements of Cedar HCP.	160 MGD
Existing System with the addition of Tolt Treatment Facility, and Tolt Pipeline 2.	171 MGD
Existing System with additions listed above and participation in Tacoma's Second Supply Project.	185 MGD

SPU has been negotiating an Agreement over the past few years to participate in the Second Supply Project (SSP) (Appendix 4-D). If the agreement is authorized by the Seattle City Council, the SSP could be completed as early as 2004. This project could provide enough water to meet SPU demands through about 2037, as well as enhance operating flexibility and reliability now and in the future.

SPU is continuing to implement its parallel planning policy for developing new sources.

SPU is continuing to implement its parallel planning policy for developing new supply sources. This will provide adequate lead-time for developing new sources under varying circumstances. In addition to pursuing the SSP, SPU will continue to work cooperatively with other water suppliers in the region, through the Central Puget Sound Water Suppliers' Forum or other venues, to develop and evaluate opportunities for innovative source development and conservation actions. These opportunities could expand with the completion of the Second Supply Project. For example, the aquifer storage and recovery project in Federal Way called OASIS could be a possible supply option for SPU after completion of the SSP.

SPU performed an analysis of alternative sources of supply in preparation for the draft Programmatic Environmental Impact Statement (EIS) for the Proposed Second Supply Project Agreement (SPU, 2000b). It used information from a report on firm yield analysis for the alternatives (SPU, 1999a; see Appendix 4-C). In addition, cost information was developed

that can be found in Appendix 4-C. This information forms the basis for the source of supply analysis presented in this WSP.

Environmental impacts are summarized in the draft Programmatic EIS for the SSP. The final EIS, when published, will reflect changes resulting from public comment provided on the draft EIS. More detailed environmental analyses would be performed for a project-specific EIS should SPU choose to develop any of these alternatives. None of the alternatives to the SSP are stand-alone new supplies. Instead, they rely on SPU's Tolt and Cedar River sources by either making additional use of these sources, or by integrating a seasonal supply into SPU's system to increase overall supply availability. The instream flow requirements of the 1988 South Fork Tolt River Hydroelectric Project Settlement Agreement and the Cedar River HCP will continue to be met with implementation of any of these supply alternatives.

SPU's options for future supply, including the Second Supply Project, are grouped into three categories:

- Those which optimize use of existing sources;
- Those which implement innovative methods of supply; and
- Those which require development of new sources.

The feasibility and cost-effectiveness of implementing each option are described in the following sub-sections. Cost effectiveness is based on the annualized cost of developed capacity (firm yield) for construction, operation, and maintenance of each supply option, including environmental studies and mitigation.

4.2.1 Optimization of Existing Sources

Participation in Tacoma's Second Supply Project Agreement. The agreement that SPU has been negotiating with Tacoma Public Utilities (TPU) provides for a water supply, transmission, and storage project referred to as the Second Supply Project (SSP). The City of Kent, Covington Water District (CWD), and Lakehaven Utility District are also parties to the agreement. The Agreement (Appendix 4-D) addresses funding, development, implementation, and operations. This project would be owned and operated by TPU.

The Agreement would allocate water from Tacoma's second water right on the Green River, together with the right to use storage at Howard Hanson Dam. It would involve payments for the design and construction of infrastructure needed to implement the project. While Tacoma would own the infrastructure under the Agreement, participants in the Agreement would have a contractual right to a portion of the pipelines' transmission

capacity. The Agreement also involves payments for environmental and fisheries enhancements.

The Agreement would enhance the efficiency of SPU and TPU's current water supply systems by making use of existing sources and by allowing SPU and TPU to share and allocate water storage in a manner that would benefit each utility and instream resources. A bilateral arrangement between TPU and SPU would allow the two utilities to optimize benefits by pooling a portion of their allocated storage at Howard Hanson Dam. Under this arrangement, SPU would get more water from storage in dry years when TPU would be able to utilize its ground water sources more heavily. This "conjunctive use" of the two water systems would optimize the overall amount of water provided to SPU and TPU for municipal and instream uses. Another bilateral arrangement would allow for mutual aid between CWD, TPU**,** and SPU in major emergencies.

A copy of the water right permit for Tacoma's second diversion is included as Exhibit L of the Agreement. The place of use is described as the area served by the City of Tacoma by direct service or interlocal agreement. The Department of Ecology (Ecology) has provided Tacoma with an opinion that delivery of water to Seattle would not require a change in place of use to Tacoma's second diversion water right permit for the Green River.

Key provisions of the Agreement include:

- *Allocation of Water Diverted under TPU's Second Water Right* - TPU has a permit for its second water right to divert up to 100 cfs (about 65 MGD) from the Green River for use in areas where it sells water. Additional instream flow requirements for the project have been provisionally established in an agreement between TPU and the Muckleshoot Indian Tribe, limiting allowable diversions during the summer. As a result, on an average annual basis, diversions from the Green River would range between about 40 and 45 million gallons per day. The Agreement allocates the water diverted among the various participants, with SPU receiving one-third of the water.
- *Infrastructure Improvements including Interconnection of TPU and SPU's Water Supply Systems* - Development of Tacoma's second water right on the Green River would entail expansion of Tacoma's existing diversion near Palmer. The Main Branch of the Second Supply Pipeline (previously referred to as Pipeline 5) would be constructed from the diversion to Tacoma. Under the Agreement, a North Branch of the Second Supply Pipeline (formerly referred to as the Tacoma-Seattle Intertie Pipeline) would also be constructed to the Lake Youngs area in order to provide water to SPU's system. Exhibit N to the Agreement describes the hydraulic capacity of the Main Branch and North Branch of the Second Supply Pipeline under various delivery

scenarios. Three interties would connect the two systems. Kent and Covington would also obtain water from interties off of the North Branch pipeline.

- *Allocation of Water to Storage* - The U.S. Army Corps of Engineers, which owns and operates Howard Hanson Dam on the Green River primarily for flood control, has been authorized to change the reservoir's operating rules. One aspect of these changes provides TPU with 20,000 acre-feet (6.5 billion gallons) of capacity behind the dam to store second diversion water right flows from mid-February through June for use later in the year. The Agreement splits the 20,000 acre-feet of storage three ways, with TPU, SPU, and the participating south King County water utilities each having a right to one-third of the storage.
- *Allocation of Water from Storage* - To enhance the benefits of storage to TPU and SPU, a bilateral arrangement within the Agreement establishes rules for allocating water taken from storage at Howard Hanson Dam. Under these rules, SPU and TPU could each withdraw one-half of their shares of stored water each year (up to 3,333 acre-feet per year for each utility). Each utility's remaining one-half share would be pooled into a variable storage allotment totaling up to 6,667 acre-feet in any given year. SPU would have the first claim to the variable storage and could claim all or a portion of it in drier years. If the entire 6,667 acre-feet of variable storage were called on by SPU, a total of 10,000 acre-feet of stored water would be available to SPU. Under the allocation rules, in any ten years prior to 2020, SPU would have the right to 40 percent of the water allocated to variable storage. After 2020, SPU would have the right to 30 percent of the water allocated to variable storage in any ten-year period.
- *Development of Potential Ground Water Resources* - To assure the availability of water to SPU from TPU's variable storage in certain years, TPU may need additional ground water supply in its system. The Agreement, therefore, also includes provisions for SPU to fund these new ground water sources for TPU.
- *Additional Provisions* - The Agreement includes other provisions related to the allocation of development costs, ownership of facilities, and granting the participant's right of first refusal to participate in the Howard Hanson Phase II Additional Water Storage Project, should it be developed.

Water delivered to Seattle would be treated at the Tacoma headworks to meet drinking water regulations.

Water delivered to Seattle would be treated by Tacoma at its headworks to meet drinking water quality standards. Initially, this water would be chlorinated but not filtered. It would be delivered to Lake Youngs, the Cedar Treatment Facility headworks or to the clearwell of the Cedar Treatment Facility. Initial blending studies indicate that the supply sources are very compatible. No potential public health or safety concerns have been identified. These issues would be more thoroughly discussed in the project-specific EIS and preliminary engineering studies.

SPU estimates that implementation of the Agreement would increase the firm yield of its water supply system by about 14 MGD, to a total of 185 MGD (Table 4-3). This should extend the time needed to develop additional water sources by about ten years. Because this source would be developed before water demands equal firm yield, Seattle's water supply would exceed its 98 percent reliability standard during this period.

The Agreement would expire when the operating life of the Project has ended. This is now set to be not less than 100 years, but could be extended. If the agreement were terminated, Seattle would have the right to participate in any subsequent project that makes use of Tacoma's second diversion water right and storage at Howard Hanson Reservoir.

The total cost of the project to SPU is estimated to be $76,092,000 (in 1999 dollars), excluding the cost of the additional conservation resources which would be offset by sale of that water to another utility. Annual operations and maintenance costs of this project are estimated to be $715,500. The total annualized cost for this project is estimated to be $446,000 per MGD of developed capacity.

Cedar Permanent Dead Storage. Except during severe drought conditions, Chester Morse Lake can be drawn down to an elevation as low as 1,532 feet – the lowest elevation that water can flow by gravity to Masonry Pool. However, Chester Morse Lake also stores a substantial amount of high quality water below this elevation, which now can only be withdrawn during severe drought conditions using the temporary pumping plants. About 34,000 acre-feet (about 11 billion gallons) of water is stored between elevation 1,532 and 1,502 feet, the lowest elevation likely to be considered for use. This volume is called "dead storage."

One option for more water is for Seattle to access dead storage at Chester Morse Lake.

The Cedar Permanent Dead Storage Project would modify the operation of Chester Morse Lake to access its dead storage on a more regular basis. As currently conceived, use of dead storage would not be required every year. Drawdowns to or below elevation 1,532 feet would be expected in one out of four years. Water right changes may be needed to reflect the final project concept. The Cedar Permanent Dead Storage Project would provide up to an estimated 39 MGD of firm yield while maintaining the instream flows committed to in the Cedar River HCP. However, under the

provisions of the Cedar HCP, SPU would forego some of this additional firm yield in order to allow it to provide additional fish benefits.

Initial planning work done for SPU (HDR-Ott Engineering, Inc., 1990) identified several design concepts for a permanent pumping plant at Chester Morse Lake. A gravity tunnel option was identified that would involve constructing a new intake in Chester Morse Lake and slightly more than two miles of tunnel from the intake to a connection with the existing Cedar Falls power tunnel near Masonry Pool. The total capital cost of the project to SPU is estimated to be $20,863,000 (in 1999 dollars), assuming an on-shore pump station, power line extension, and discharge piping routed along the reservoir bottom. Annual operations and maintenance costs of this project are estimated to be $569,000. The total annualized cost for this project is estimated to be from $53,000 to $104,000 per MGD of developed capacity, depending on the firm yield of the project.

Lake Youngs Drawdown. Water diverted from the Cedar River for SPU's water supply is now normally routed to the Lake Youngs Reservoir and then through the existing Lake Youngs tunnel to the Control Works and on to SPU's distribution system. Historically, SPU has operated Lake Youngs to balance the Cedar supply, with the lake typically fluctuating within the top 3 feet, although drawdowns of as much as 10 feet have occurred in the past. SPU does not currently draw down Lake Youngs to provide additional firm yield to its system. This supply option proposes to use storage at Lake Youngs and additional diversions from the Cedar River to increase SPU's overall supply. SPU's planned Cedar River Water Treatment Facility will include a new multi-level intake in Lake Youngs. The multi-level intake will allow SPU to withdraw water from various levels to better manage the quality of untreated water supplied to the treatment plant. Although drawdown of Lake Youngs below historic levels is not part of the Cedar Treatment Facility proposal, a multi-level intake could potentially allow the Lake Youngs Reservoir to be drawn down to provide additional firm yield to the water supply system. To accomplish this, however, additional environmental assessment would need to be conducted and additional treatment process(es) (e.g., filtration) would likely have to be added to the Cedar Treatment Facility because drawdown would increase turbidity and ozone treatment would be ineffective at reducing increased turbidity levels.

Although this supply option would allow drawdowns of up to 28 feet, drawdowns would not be required every year to increase the firm yield of SPU's overall supply system. Computer modeling by SPU (SPU, 1999a) suggests the reservoir could be drawn down for water supply in about one out of 4.5 years on average. About 20 MGD of additional system-wide firm yield could be achieved with the project.

The total capital cost of the project is estimated to be $197,310,000 (in 1999 dollars), primarily for additional treatment capability. Annual operations and maintenance costs of this project are estimated to be $2,369,000. The total annualized cost for this project is estimated to be $835,000 per MGD of developed capacity.

South Fork Tolt Additional Drawdown. The South Fork Tolt Reservoir is capable of storing 18.3 billion gallons between the lowest gate elevation on the existing intake (elevation 1,660 feet) and its normal maximum operating level of 1,765 feet. However, because of the potential for high turbidities with drawdowns to elevation 1,660 feet, drawdowns are limited to a normal minimum elevation of 1,710 feet, even with the new Tolt Treatment Facility. The South Fork Tolt Additional Drawdown option would involve operating the existing Tolt system with a minimum operating elevation of 1,660 feet. This supply option could result in the need for new or expanded treatment processes, such as the addition of sedimentation basins, at the Tolt Treatment Facility site depending on water quality studies. This option would require no physical improvements at the South Fork Tolt Reservoir.

Implementation of South Fork Tolt Additional Drawdown would not result in lowering the reservoir to elevation 1,660 feet every year. Computer modeling by SPU suggests that implementation of this option could result in an additional 8 MGD of system-wide firm yield with the reservoir falling to or below elevation 1,710 feet in one out of six years on average.

The total capital cost of the project is estimated to be $14,908,000 (in 1999 dollars). Annual operations and maintenance costs of this project are estimated to be $457,500. The total annualized cost for this project is estimated to be $193,000 per MGD of developed capacity.

North Fork Tolt Diversion Project. Early planning documents for development of the Tolt River by Seattle considered use of the North Fork Tolt River in conjunction with the South Fork Tolt River. In 1936, Seattle submitted a water rights application for 280 cfs (181 MGD) from the North Fork Tolt River, along with a water right application for the South Fork Tolt River. A phased development approach was taken: the South Fork Tolt water supply facilities were built by the 1960s and hydropower generation was added in the mid-1990s. The North Fork Tolt Diversion Project was envisioned as the final component of Seattle's Tolt Water Supply System. This water supply option would include a new diversion weir and intake on the North Fork Tolt River, and one or two large-diameter pipelines to the existing Tolt Regulating Basin. The pipelines would be about 13,000 feet long.

With development of this supply option, water from the North Fork Tolt River would be diverted to the Regulating Basin. Diversions could occur at any time, provided that instream flow requirements on the North Fork

Tolt River are met. Computer modeling by SPU indicates the North Fork Tolt Diversion could result in additional system-wide firm yield between 8 and 40 MGD, depending on instream flow requirements that would need to be negotiated.

While this supply option would not necessitate the development of new storage capacity on the Tolt supply system, it would likely require improvements to the Tolt Treatment Facility to enhance its ability to treat highly turbid water. In addition, the capacity of the treatment facility would have to be increased to as high as 240 MGD. Expanded transmission capacity would also be needed and could be achieved by completing the remaining phases of Tolt Pipeline No. 2.

The total capital cost of the project is estimated to be $111,210,000 (in 1999 dollars). Annual operations and maintenance costs of this project are estimated to be $1,281,000. The total annualized cost for this project is estimated to be between $234,000 and $1,170,000 per MGD of developed capacity, depending on the firm yield of this project.

4.2.2 Implementation of Innovative Methods

SPU supports and encourages use of reclaimed water.

Reclaimed Water Use. SPU recognizes the value of reclaimed water as a means to conserve and extend the useful life of the potable water supply. SPU supports and encourages coordinated regional water, wastewater, and reclaimed water planning efforts. SPU recognizes that King County is exploring the development of reclaimed water and may ultimately be a wholesale supplier. During the spring of 2000, King County, in conjunction with its Reuse Task Force, requested proposals for pilot projects that would reuse highly treated wastewater for non-potable uses. The Task Force is concurrently developing a public outreach plan and is developing the criteria for the evaluation and selection of these pilot projects. The County's intention is that the pilot projects provide non-potable reused water for irrigation or industrial applications. In the long-term, the County intends to research the possibility of applications such as streamflow augmentation and indirect potable water supply. The development and operation of the pilot projects will allow the County and the region to evaluate both the technical feasibility and cost effectiveness of the use of reclaimed wastewater.

Additional Conservation Measures. SPU currently conducts a variety of water conservation programs which already include enhanced conservation measures. The current conservation programs include measures that go beyond what DOH considers to be the minimum acceptable program for a large system. Nonetheless, the Programmatic EIS did evaluate additional conservation measures consisting of those additional programs included in the "Technical Potential Package" identified in the CPA (Appendix 4-B) but were not included in the 1% Conservation Program. These programs include a wide variety of conservation measures, including certain water

reuse programs, such as using greywater and stormwater in certain landscaping and internal applications. The Additional Conservation option could provide peak season savings in 2020 of up to 12 MGD (or average annual savings of 8 MGD) beyond those expected from the existing programs (including the 1% Conservation Program). The total annualized cost for these measures is estimated to be $2,490,000 per MGD of the total average annual savings in 2020.

SPU's Highline Wellfield can be artificially recharged to supplement naturally occurring recharge.

Aquifer Storage and Recovery. SPU's Highline Wellfield can be artificially recharged to supplement naturally occurring recharge and maximize ground water production (Section 6). The Wellfield has been operated in this manner since 1994. Studies based on field data and computer modeling have indicated that it may be possible to increase production from the Highline Wellfield by the addition of a fourth well located near SPU's Boulevard Park Well. Total annual production would be increased by 340 million gallons and would be delivered at a rate of up to 2 MGD. Although the new well could be useful as an emergency source of supply or as a peaking supply, it would provide a relatively small amount of additional supply on an annual basis. Therefore, it is not currently being pursued as a supply option.

4.2.3 Development of New Sources

Snoqualmie Aquifer Project. A new source under consideration is the development of the Snoqualmie Aquifer with an interconnection to SPU's Tolt pipeline. The project is being sponsored by the East King County Regional Water Association (EKCRWA) with assistance from SPU. Under the current concept, this project would only operate during the summer months and would involve pumping ground water from the Snoqualmie Aquifer and introducing the ground water into the Snoqualmie River upstream of Snoqualmie Falls. Withdrawals from the Snoqualmie River for water supply would take place near Carnation (downstream of the confluence with the Tolt River) where the water would be treated at a new filtration plant and pumped to SPU's Tolt Pipeline No. 2.

The water amount withdrawn would include both surface water and ground water introduced into the river. The amount of "ground water" that could be withdrawn is assumed to equal the predicted net increase in streamflow, taking into account reductions in base flow due to ground water pumping. The amount of "surface water" that could be withdrawn is assumed to be no more than the amount of surface water above instream flow requirements at Carnation, as required by the Washington State Instream Resources Protection Program. New water rights would be required for the ground water and surface water withdrawals.

This supply option would include development of a Wellfield with a total capacity of 40 MGD in the upper Snoqualmie River basin, in the general

vicinity of North Bend. In addition to the Wellfield, this option would include:

The Snoqualmie Aquifer Project is a new source that could include both ground and surface waters.

- Facilities to aerate ground water and discharge it to the Snoqualmie River upstream of Snoqualmie Falls;
- A surface water diversion weir and intake structure in the lower Snoqualmie River near Carnation and associated pump station;
- A new, 52 MGD water treatment facility; and
- About 3 miles of pipeline connection between the pump station and treatment plant and between the treatment plant and SPU's Tolt pipeline.

The total firm yield produced by this project would be 16 MGD. Of that, 10 MGD could be available to serve SPU's existing customers. Six MGD could be utilized by utilities not now served by SPU.

The total capital cost of the project to SPU is estimated to be $48,694,000 (in 1999 dollars), excluding right-of-way acquisition and assuming costs are allocated in proportion to the firm yield available to SPU. Annual operations and maintenance costs of this project are estimated to be $496,000. The total annualized cost to SPU for this project is estimated to be $403,000 per MGD of developed capacity assumed available to SPU.

4.3 Water Rights Evaluation

SPU currently utilizes surface water from the Cedar River and the South Fork Tolt River, and ground water from the Highline Wellfield. The City holds various water rights for use of these water sources. Additionally, the City has water rights applications on file with Ecology for potential future sources of supply. These sources include the North Fork Tolt River, the Snoqualmie Aquifer, and additional yield from the Highline Aquifer. This section provides a description of all of these water rights. Tables 4-4a and 4-4b provide a summary of this information.

Table 4-4a
Existing Water Rights Status

Permit Certificate or Claim #	Name of Rightholder or Claimant	Priority Date	Source Name/ Number	Primary or Supplemental	Existing Water Rights		Existing Consumption		Current Water Right Status (Excess/Deficiency)	
					Maximum Instantaneous Flow rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)
Permits										
1. S1-25929	City of Seattle Water Department	8/17/1990	Cedar River: Temporary Pumping Plant	Supplemental (Term Permit)	390 cfs (252 MGD)	N/A	Note 1			
2. S1-25330P	City of Seattle Water Department	8/22/1988	Cedar River: Highline Aquifer Storage & Recovery (ASR)	Primary	10 cfs (6.5 MGD) (Oct to May)	4,800 acre-feet (1,564 MG)	3.5 cfs[3] (2.3 MGD)	669 acre-feet[2]	6.5 cfs (4.2 MGD)	4,131 acre-feet
3. 10602	City of Seattle Water Department	7/14/1936	South Fork Tolt Diversion	Primary	280 cfs (181 MGD)	168,000 acre-feet	264 cfs[5] (170 MGD)	58,251 acre-feet[4]	16 cfs (11 MGD)	109,749 acre-feet
4. R-206	City of Seattle Water Department	7/14/1936	South Fork Tolt Reservoir	Primary	Storage	Storage 57,830 acre-feet		Storage 57,830 acre-feet		Storage 0 acre-feet
5. G1-24619	City of Seattle Water Department	3/7/1985	Highline Well Field: Boulevard Park Well	Primary	4000 gpm (5.8 MGD)	To be determined	2,900 gpm[6] (4.18 MGD)	764 acre-feet[7]	1,110 gpm (1.6 MGD)	To be determined
6. G1-24621	City of Seattle Water Department	3/7/1985	Highline Well Field: Riverton Heights Well	Primary	4000 gpm (5.8 MGD)	To be determined	6,300 gpm[8] (9.07 MGD)	2,422 acre-feet[9]	-2,292 gpm[10] (-3.3 MGD)	To be determined
Claims										
1. 068624	City of Seattle Water Department	1888	Cedar River and Chester Morse Lake	Primary	465 cfs (300 MGD)	336,650 acre-feet[11] (300 MGD)	350 cfs[12] (226 MGD)	161,312 acre-feet[13] (144 MGD)	115 cfs (74 MGD)	175,338 acre-feet[11] (156 MGD)
2. 068623	City of Seattle Water Department	1926	Lake Youngs	Primary		Storage 33,770 acre-feet		Storage 33,770 acre-feet		Storage 0 acre-feet
TOTAL[14]	*********	*****	*******	**********	493 MGD	504,650 acre-feet	339 MGD	222,749 acre-feet	154 MGD	285,087 acre-feet
Intertie Name/Identifier[15]										

Notes:

1. Not included in water rights calculations; pumping plants have been operated for testing only; would be used only under conditions of extreme drought, or under specific conditions detailed in the Cedar River HCP Instream Flow Agreement.
2. Maximum volume recharged to date: December 1994 through March 1995; Recharge period is October through May.
3. Per Integrated Water Resource Management System (IWRMS) average rate over 24 hours recorded 1/3/95.
4. Tolt Pipeline 24-hour volumes from IWRMS (1985-1999); Highest occurred in 1994.
5. Flow diverted from South Fork Tolt River and Measured by Seattle City Light at Powerhouse.
6. Per Highline Well Field, O&M Manual; Maximum range of normal operations.
7. Maximum well field use occurred between June and December 1992.
8. Per Highline Well Field, O&M Manual; Maximum range of normal operations.
9. Maximum well field use occurred between June and December 1992.
10. During the exploratory and developmental phases of the Highline Well Field in the 1980s, a number of applications were filed with Ecology.
    While 2 permits (G1-24619 and G1-24621) were issued and Ecology has indicated that the permits allow continuing use of the wells leading to certificates, the table shows that there is a shortfall in the allowable instantaneous demand (Qi) for the Riverton Wells.
    Ecology staff had earlier worked out a restructuring of the initial applications to provide for eventual certification as 2 separate well fields, Riverton and Boulevard Park.
    Ecology staff's heavy workload has not allowed this process to move forward yet.
11. Per the Cedar River Watershed Habitat Conservation Plan, one-third (100 MGD) of this claim, on an annual average basis, would be dedicated to instream flows, i.e., not available for M&I use.
12. Per IWRMS data 226 MGD was recorded 6/23/96 (7:00 am reading).
13. Landsburg diversion calendar year 1990: 144 MGD, 52,560 mg, 161,312 acre-feet.
14. Individual sources are reported in the table, so the summation should be considered approximate only. Emergency source, ASR and storage not included. Yield from Highline Well Field has not been perfected, but permits are valid.
15. Not applicable. Interties are used to supply water to wholesale water purveyors.

Table 4-4b
Pending Water Rights Status

Water Right Application	Name on Permit	Date Submitted	Source Name	Primary or Supplemental	Pending Wa
					Maximum Instantaneous Flow Rate (Qi) Requested
1. S-4254	City of Seattle Water Department	Filing date 07/14/36 being held in abeyance	North Fork Tolt River	Primary	280 cfs (181 MGD)
2. Gl-24620	East King County Regional Water Association and Seattle Water Department	1/19/1994	Snoqualmie Aquifer	Primary	41,600 gpm
3. S1-27877	East King County Regional Water Association and Seattle Public Utilities	1/29/1998	Snoqualmie River	Primary	100 cfs
4. G1-24620	City of Seattle Water Department	3/7/1985	Highline Well Field: Glacier Well	Irrigation or other non-potable use only	To be determined
5. G1-24824 (Note 1)	City of Seattle Water Department	4/14/1986	Highline Well Field: Not named	Primary	4000 gpm (5.8 MGD)
6. G1-24825 (Note 1)	City of Seattle Water Department	4/14/1986	Highline Well Field: Boulevard Park Well	Primary	4000 gpm (5.8 MGD)

1. During the exploratory and developmental phases of the Highline Well Field in the 1980s, a number of applications were filed with Ecology.

4.3.1 Cedar River Supply System

The City relies on a combination of documented water right claims and permits for the Cedar River water supply system which allow for:

- Storage of water in Chester Morse Lake and diversion of water at the Landsburg Diversion Dam for municipal and industrial (M&I) use;
- Storage of water in Lake Youngs for M&I use;
- Pumping from the dead storage of Chester Morse Lake for M&I use; and
- Diversion of water at Landsburg for use as recharge water for the Highline Wellfield Aquifer.

Claim No. 068624 – Cedar River Storage and Diversion. In 1974, the City documented its pre-existing water claim for storage of up to 160,000 acre-feet, and diversion of up to 465 cfs (300 MGD) of Cedar River water. The claim has not been subjected to an adjudication process. Storage is accomplished by impounding water behind the Masonry Dam, located at river mile 35.6 in the municipal watershed approximately 30 miles east of Seattle. Water is released from storage either through valves and gates located on the dam, or through penstocks leading to the Cedar Falls Hydroelectric Plant. Flows used for power generation are returned to the river approximately 2 miles downstream of Masonry Dam. Seattle City Light holds a water right certificate to use this water for power generation. Diversion of water for M&I purposes occurs at the Landsburg Diversion Dam, at river mile 21.9.

The HCP binds the City to guaranteed instream flows in the Cedar River below Landsburg.

Through its Cedar River Watershed HCP, the City is binding itself to guaranteed instream flows in the river below Landsburg. The minimum instream flows for the Cedar River established in 1979 by the State were not binding on Seattle because of the seniority of its claim. As part of the HCP commitments, the City will be dedicating one-third of this claim to instream flows for the 50-year duration of the HCP. This would commit the City to keeping diversions below 200 MGD on an average annual basis. The instantaneous diversion rate (Qi) would not be affected. SPU will be working with the State to develop the legal mechanism to dedicate this portion of the claim to instream flows. The place of use for this claim is described by specific township, range, and section.

Claim No. 068623 - Lake Youngs Storage. Water diverted from the Cedar River at Landsburg is treated, then enters a 10-mile long conveyance and is discharged into Lake Youngs for delivery to the transmission system. In 1974, the City documented its pre-existing water claim for storage of up to 33,770 acre-feet of Cedar River water in Lake Youngs. The claim has not been subjected to an adjudication process. The place of use for this claim is the same as for the Cedar River Claim No. 068624, described above.

Permit No. S1-25929 – Temporary Chester Morse Lake Pumping Plants. As described earlier, a substantial quantity of water in Chester Morse Lake is in "dead storage" which can only be accessed by pumping. The City has two barge-mounted pumping plants on the lake for use in the event of droughts. Each plant has the capacity to pump up to 120 MGD of high quality water from Chester Morse Lake into Masonry Pool, where it is released for downstream uses (instream flows and M&I supply). The City was granted a 15-year water right permit in 1992 with a Qi of 252 MGD. The permit is conditioned on the instream flows measured at Renton established in 1979 and codified in WAC 173-508. Being a temporary permit, it will not progress to certificate. The HCP contemplates that the City will pursue an extension or new permit to allow more flexible use of the pumping plants to achieve fish benefits.

The place of use for this permit is "the area served by SPU and its wholesale water purveyors as established in the 1993 WSP and periodic updates."

Permit No. S1-25330P – Aquifer Recharge Water. Shortly after the Highline wells were constructed and put into service, the City investigated the feasibility of injecting surface water into the ground water aquifer to promote faster recharge. A temporary permit was granted in August 1988 to divert up to 10 cubic feet per second of water from the Cedar River at Landsburg for this purpose. The right is junior to minimum instream flow requirements set by the State in 1979, and diversion may take place only during the months of October through May. In 1997, the City asked Ecology to extend the term of the temporary permit until finalization of the Cedar River Watershed HCP. In February 1999, Ecology granted an extension of time until February 2003. The HCP, which is being implemented beginning in mid-2000, will define some important conditions under which Seattle can divert water from the Cedar River. The City will then seek to convert the temporary permit to a regular permit, conditioned on the HCP instream flow provisions. The place of use is defined as Highline Wellfield and the area served by the City of Seattle (by direct or interlocal agreement).

4.3.2 South Fork Tolt River Supply System

The City has two separate water rights that pertain to the South Fork Tolt River water supply system which allow for:

- Storage of water in the South Fork Tolt Reservoir for M&I and hydropower use.
- Diversion of water at the South Fork Tolt Dam for M&I and hydropower use.

These water rights are described as follows:

Permit No. R-206 – South Fork Tolt Reservoir Storage. The City was originally issued a water right permit in 1957 to store up to 57,830 acre-feet of water in the South Fork Tolt Reservoir. A superseding permit was issued in 1997 adding hydropower as a permitted use, in addition to M&I. Addition of the hydropower facility to the South Fork Tolt system led to licensing under the Federal Energy Regulatory Commission (FERC). The superseding water right permit is conditioned on the conditions of the FERC Project No. 2959 Settlement Agreement, including instream flows. The place of use for this permit is "the area served by SPU and its wholesale water purveyors as established in the 1993 WSP and periodic updates." The City continues to grow into full beneficial use of this water right.

Permit No. 10602 – South Fork Tolt Diversion. The City was originally issued a water right permit in 1957 to divert up to 181 MGD (Qi) and 168,000 acre feet annually at the South Fork Tolt Dam. A superseding permit was issued in 1997 adding hydropower as a permitted use, in addition to M&I. Addition of the hydropower facility to the South Fork Tolt system led to licensing under the FERC. The superseding water right permit is conditioned on the conditions of the FERC Project No. 2959 Settlement Agreement, including instream flows. The place of use for this permit is the "area served by SPU and its wholesale water purveyors as established in the 1993 WSP and periodic updates." .

4.3.3 Highline Wellfield Supply System

Temporary Permit nos. G1-24621, G1-24624, and G1-24825 – Boulevard Park and Riverton Heights Wells. In an aquifer located south of Seattle and immediately north of Sea-Tac International Airport, the City currently operates three water supply wells with a combined capacity of approximately 10 MGD. Two wells, referred to as Riverton Heights 1 and 2, are located near the City's Riverton Heights Reservoir, and draw water from a depth of about 330 feet. The Boulevard Park Well is located approximately one mile north of Riverton, and draws water from a depth of about 250 feet. Seattle was issued temporary permits for the operation of the three wells in 1987. In October 1997, SPU requested Ecology convert the three temporary permits into two separately permitted Wellfields; one centered at Riverton Heights and the other at Boulevard Park, each with a permanent status water right. Ecology has not yet acted on this request. Until they do so, the continued operation of the Wellfield is approved under the temporary permit. The place of use for the wells is defined as the area served by Seattle.

4.3.4 Potential Future Water Supply Sources

Application No. S-4254 – North Fork Tolt River Diversion. The North Fork Tolt Diversion is a future water supply source option for Seattle and the region that has been identified in the past as a water supply option. Most recently it was identified in Seattle's 1993 WSP and in the ongoing Snohomish Basin Regional Planning Process. Seattle filed a water rights application in 1936 for an instantaneous flow of 181 MGD, and an annual maximum volume of 203,000 acre feet. Seattle has requested processing of the application be held in abeyance for the time being, and, Ecology has not processed this application to date.

Permit No. G1-24825 – Possible Fourth Well at Highline Wellfield. As noted above, the City has temporary permits to operate the three wells at Highline Wellfield, with a request for two separately permitted Wellfields. The requested Boulevard Park Wellfield water right would accommodate a possible additional production well. The feasibility of an additional well, potentially adding 1 to 2 MGD of peaking capacity to the system, is being evaluated.

Permit No. G1-24620 – Possible Non-Potable Well at Glacier. In addition to the three water supply wells the City operates at the Highline Wellfield, a production well at the nearby Glacier site was completed in 1986. It draws water from the deep aquifer at a depth of about 550 feet. The City was issued temporary permits for the operation of the well in 1987. Tests of the well indicated that the sustainable production rate over the planned use period would be about 700 to 900 gallons per minute. Water quality concerns, specifically the presence of hydrogen sulfide, led the City to abandon plans to develop this well as a potable supply. In October 1997, the City requested Ecology to extend the temporary permit until 2003 to investigate and implement a production well for non-potable uses, such as irrigation for the ball fields in the nearby park. Ecology has not yet acted on this request.

Application Nos. G1-27384 and S1-27877 – Snoqualmie Aquifer Project. Study of the Snoqualmie Aquifer Project has been in progress since 1992 under the sponsorship of the EKCRWA. Seattle is a partner in the project, and is a co-applicant with EKCRWA in the water rights process. As originally conceptualized, the project was to be developed as a conventional ground water supply. However, in late 1997, an alternative was proposed involving the conjunctive use of surface water and ground water.

A joint water right application (G1-27384) was filed with Ecology by EKCRWA and Seattle Water Department (now Seattle Public Utilities) on January 19, 1994, to withdraw 60 MGD from the Upper Snoqualmie basin.

This is equivalent to 92 cubic feet per second (cfs), or 67,200 acre-feet per year (AF/y).

The change in concept necessitated that an application be filed with Ecology for a surface water right. The surface right application (S1-22877) was submitted by EKCRWA and was assigned a priority date of January 29, 1998. The applicants are requesting a withdrawal of not more than 100 cfs for a regional water supply. The maximum quantity to be used annually is 72,000 acre-feet (AF/y).

4.4 Water System Reliability Analysis

This section summarizes the efforts SPU takes to ensure an adequate quantity of water can be provided at all times. Discussion of water quality reliability is contained in Section 5.

4.4.1 Source Reliability and Firm Yield

Definition and Calculation of Firm Yield. Firm yield estimates are used to evaluate the ability of Seattle's surface and ground water sources to provide for the water demands of the system. Because of the wide variation in streamflows that can be experienced from year to year, the amount of water that can be delivered from a water supply system can vary greatly. It is usually not economical to develop water supply sources that will meet full system demands under the driest conditions. A reliability standard is used to balance the level of risk of not being able to meet water demands in drier years with the cost of developing supply sources. The level of demand that can be supplied from a water supply system that meets the reliability standard is termed the "firm yield" of that water supply system. The firm yield is compared to long-term forecasts of water demand to determine when new sources need to be on-line to maintain the level of supply reliability. Firm yield estimates are periodically updated to reflect more recent hydrology, and changes to the physical facilities and operating policies or procedures.

The supply reliability standard used to determine firm yield of SPU's system is 98%.

As stated in the Level of Service Policy in the 1993 WSP, the supply reliability standard used for determining the firm yield of SPU's water system is the water industry standard of "98 percent reliability." Under this definition, the firm yield is the amount of water that is assured for delivery in all but the driest 2 percent of years on average without lowering reservoirs below normal minimum operating levels. Prudent water system operational practice may result in some water curtailment actions more frequently than twice in one hundred years, even when this reliability standard is met. Further explanation of the 98 percent reliability standard is presented in Table 4-5.

Table 4-5
Understanding the 98% Reliability Standard

What it means	What it does not mean
The 98% reliability standard means that there is a 2% chance in any year of having a shortfall(1).	The 98% reliability standard does not mean that there is only a 2% chance in any year of having customers reduce their consumption through curtailment.
Applying the 98% reliability standard to a 100-year historical record means that a shortfall would statistically occur in only two years in that period.	Applying the 98% reliability standard to a 100-year historical record does not mean that a water shortage would occur only once in 50 consecutive years. There is no guarantee that shortages will not occur in back-to-back years.
In 98 of the 100 years, demand could have been met without curtailments or other extraordinary supply enhancements or demand management measures, if hindsight was used. Water managers do not have the benefit of hindsight and, to avoid risks of shortfalls, managers will ask for customers to reduce consumption in more than 2 of the 100 years. Prudence calls for steps to be taken before they become essential.	The 98% standard does not mean that managers will ask for curtailments in only 2 of 100 years. Water managers will not know that conditions are equivalent to one of the 2 shortage years in 100 until the year is over.
The firm yield number produced by the 98% reliability standard represents the minimum amount of water that can be delivered in 98 of the 100 years. In most of these years, the system can deliver more than the firm yield; in 2 of these years the system will deliver less.	The firm yield number produced by the 98% reliability standard does not represent the maximum amount of water that can be delivered in all 98 of the 100 years.
98% is the minimum reliability. The standard is applied at the point in the planning horizon where demand equals the firm yield number produced by the 98% reliability standard. Prior to that point, demand is less than the firm yield number and the supply reliability is greater than 98%.	98% is not the maximum reliability. Use of the reliability standard does not mean that a new source is 98% reliable when first brought on line, only to diminish as demand grows. In fact, a source's reliability is greater than 98% when it is first brought on line and diminishes to 98% when demand grows to equal firm yield.

(1) A shortfall or failure occurs when the water supply system is not able to meet uncurtailed water demands or critical instream flow requirements.

The 98 percent reliability standard is applied by computing the number of years that the total system "runs out of water." This is shown in the model results as a failure to meet water system demands and minimum instream flow requirements, because water levels in the reservoirs fall below normal minimum operating levels and no other sources are available. To calculate firm yield at 98 percent reliability, two "failures" are allowed in 100 years of historic record. When the historic period of record contains less than 100 years, the number of failures is set such that the total percentage of failure years in the period of record is as close to 2 percent as possible. Thus, for the 64.5 years of historic record currently used by Seattle, only one failure is considered allowable.

This standard of reliability was established in the 1985 Comprehensive Water System Plan. It was based on a report that examined the risk

involved in different reliability standards (Charles Howard and Associates, Ltd., Risk Analysis: Water Supply Reliability and Risk, August 1984.). The report confirmed the reasonableness of using the 98% standard, indicating an economic loss to the region because the cost of more frequent curtailments that would accompany a lower reliability standard would outweigh the savings associated with deferring construction of new sources.

While lowering the reliability standard to below 98 percent would increase the firm yield of existing sources and delay the need for new source development, it would not come without impacts to customers and the river systems. A lower reliability standard would increase the frequency and level of curtailments requested or required of customers. Instream flows in the rivers would be lowered to critical flow levels more frequently. Also, because more water would be diverted from the rivers, stream flows would be at minimum levels more frequently and average stream flows would be lower. The converse would occur if the reliability standard were raised above 98%: less water would be used from existing sources and development of new sources would need to be accelerated to meet customers' demands. Should further analysis be conducted on lowering the reliability standard it would be important to closely examine: the impact on stream flows and habitat; ability to meet instream flow commitments; frequency, duration and severity of curtailments; and acceptance by DOH that state public health and safety requirements are met.

The 1993 Water Supply Plan included a recommendation action that SPU "work with wholesale customers to determine if a revised approach to defining reliability, calculating yield or timing acquisition of new resources should be used in the next Water Supply Plan." SPU staff and purveyor representatives formed a Task Force with the intent to develop a customer-based definition. Analyses conducted for this effort focused on using frequency of curtailment as a measure of supply reliability. After many months of discussion and numerous analyses, it became apparent that it would be impossible to include into a computer model the types of information used to activate the Water Shortage Contingency Plan and set the appropriate level and type of curtailments. Consequently, SPU decided to continue using the 98 percent reliability standard to assess yield and reliability of water supply.

The estimate of firm yield for SPU's water system is currently calculated using a computer simulation of the water supply sources operated in conjunction with one another. For the surface water supplies on the South Fork Tolt and Cedar Rivers, the simulation is based on mass balance principles. Historic inflows are routed through the supply reservoirs using operational rules to meet downstream water system needs and minimum

instream flow requirements within the physical constraints of the transmission/treatment system and supply reservoirs. The historic record of inflows developed for the firm yield calculations extends from water year 1929 (i.e., October 1928) to the most recent year with available in-stream flow data. Withdrawals from ground water sources are also included in the simulation to meet water system needs. The computer simulation uses a weekly time step to meet average monthly water system demands.

Modeled firm yield is reported as a system-wide total for the surface water supplies and ground water sources forming the SPU water system. Firm yield is expressed as an average annual delivery rate (whole number of million gallons per day, MGD), but can be determined for seasons within a year by appropriately applying the delivery pattern.

On average, the Cedar delivers 70%, the Tolt 29%, and the Highline Wellfield 1% of the total water system demand.

Results of Modeling Firm Yield. The firm yield for SPU's existing water supply system without the addition of the Tolt Treatment Facility was recently recomputed and was found to be 160 MGD (Table 4-3). This firm yield estimate includes 5 MGD for the additional flexibility afforded by the non-binding aspects of the minimum instream flows for the Cedar River at Renton (given in the Washington State Instream Resources Protection Program). Based on the firm yield model results, deliveries from each supply source vary from year to year depending on the hydrologic conditions of each supply source. On average, for the existing system configuration, the Cedar River system delivers about 70 percent, the South Fork Tolt River system delivers about 29 percent, and Highline Wellfield delivers about 1 percent of the total water system demand.

The firm yield was also computed for the water system changes currently planned to be in place by the year 2000 including the Tolt Treatment Facility, Tolt Pipeline 2, and the Cedar River HCP. Completion of the Tolt Treatment Facility in 2000 will allow additional drawdown of the South Fork Tolt Reservoir from elevation 1,730 to 1,710 feet to access an additional 11,700 acre feet of stored water. Because of this increased drawdown, the minimum instream flow requirements for the South Fork Tolt River would be increased as specified in the 1988 South Fork Tolt River Hydroelectric Project Settlement Agreement that was negotiated and committed to as part of the FERC licensing process for the hydropower plant. The capacity of the new treatment plant will be 120 MGD. In 2000, Tolt Pipeline 2 (excluding Phases V and VIB) and the Tieline will also be completed, and the transmission capacity of the Tolt system will be raised from 85 to 135 MGD. In addition, the new minimum instream flow requirements as proposed in the Cedar River HCP are expected to be in effect. The guaranteed HCP instream flow requirements include normal and critical minimum instream flow commitments as well as the additional supplemental flows or blocks of water. The system-wide firm yield for

these planned system changes was determined to be 171 MGD. Additional analyses also showed that adoption of the HCP instream flows had no impact on the firm yield; that is, no yield loss or gain can be attributed to the HCP instream flows. However, the HCP includes an interim commitment (5 to 10 years) to manage its Cedar River operations in such a manner that annual Cedar diversions average between 98 to 105 MGD. This places a short-term constraint on SPU's future contractual water sales commitments.

Based on the above estimates of firm yield and the level of demand, the SPU water system source reliability is currently higher than the standard of 98 percent. Firm yield is more fully explained in the Firm Yield Report on Source Alternatives (SPU 1999a; see Appendix 4-C).

Climate Change and Variability. During the 1990s, communities world-wide heightened their attention to the discussion on global climate change and climate variability. Local and international researchers studying future long-term global climate change scenarios are predicting significant impacts to the Earth's water resources. For example, the Joint Institute for the Study of the Atmosphere and Oceans[1] (JISAO) Climate Impacts Group at the University of Washington has produced computer-modeled Pacific Northwest regional warming scenarios that indicate a potential rising of the mean winter snow line along the western Cascade Range where Seattle's current surface water sources are located. The modeled scenarios to date have suggested that a higher mean winter snowline could produce less accumulated snowpack. This, in turn, could lead to greater and more frequent risks for experiencing water availability problems for Seattle.

Conditions such as El Niño and La Niña affect Seattle's water sources.

How global climate change will actually manifest itself in the years and decades ahead is, of course, unknown. SPU is actively engaged in the global climate change discussions and SPU's water managers are keeping abreast of developments made by researchers. Scientific information has become available from recent atmospheric and oceanic conditions, such as El Niño and La Niña in the tropical Pacific Ocean and the Pacific Decadal Oscillation detected in the northern Pacific Ocean. This information is being applied by the SPU's water managers to better manage Seattle's water supply in the face of hydrologic uncertainty.

4.4.2 Water Right Adequacy Assessment

Seattle has adequate water rights to meet system water demands beyond the 20-year planning horizon. Table 4-4a showed the annual and

[1]JISAO is a joint institute of the National Oceanic and Atmospheric Administration and the University of Washington. Principal players in JISAO include the Department of Atmospheric Sciences, the School of Oceanography, the Pacific Marine Environmental Laboratory, the National Weather Service, and the National Marine Fisheries Services.

instantaneous quantities of the various documented water rights claims and permits. The highest level of demand forecast for year 2020 is 163 MGD on an average annual basis (see Table 2-3 for demand with current and new customers). If this "worst case" demand level is realized by 2020, then Cedar River diversions are expected to average less than 110 MGD on an average annual basis, South Fork Tolt River diversions are expected to average less than 60 MGD, and supply from Tacoma would average around 10 MGD.

Because of the configuration of the SPU supply system, allowing for the conjunctive operation of the supply sources and use of Lake Youngs and in-town distribution reservoirs, 2020 peaking demands can also be met within the limits of existing Tolt and Cedar water rights. During the peak week in 2020, total system demand is forecasted to be approximately 280 MGD, with 120 MGD being supplied from the Tolt, and 160 MGD being supplied from the Cedar (Section 3). The instantaneous flow diverted from the Cedar and the South Fork Tolt rivers is forecasted to remain at or below the historic instantaneous peaks.

Over the span of this WSP planning horizon, SPU's ability to meet future demand is not constrained by water rights. On a longer planning horizon, the reliable firm yield of the supply sources is constrained by hydrology, available storage, and instream flow commitments. (Section 6)

4.4.3 Highline Wellfield Monitoring Well Network

SPU monitors groundwater levels in the vicinity of its Highline Wellfield, as part of its management of this source of supply. Underlying the Highline area are three water-bearing, sand and gravel formations now known as the Shallow, Intermediate and Deep Aquifers. The aquifers are arranged in layers and separated by much less pervious, silt and clay layers which act as aquitards. At the land surface, over much of the Highline area, is a highly compacted layer composed of glacial till. SPU has three production wells tapped into the Intermediate Aquifer.

SPU maintains a network of six monitoring wells and three production wells in the Highline Wellfield.

SPU maintains a network of six monitoring wells and three production wells in the Highline Wellfield. Three of these wells are being used to monitor water levels in the intermediate aquifer, two for the shallow aquifer, and one for the deep aquifer. Aside from the monitoring wells, the three production wells constantly transmit their water levels from the intermediate aquifer to SPU's Operation Control Center (OCC) via SCADA.

All monitoring well sites use multi-channel (except one site, which uses a single-channel) data acquisition units (Aquistar from Instrumentation Northwest, Inc.). Terrasys 3.0, a utilities and communication software package, enables communications with the data logger via laptop to view and manipulate the data, as well as to convert the data to printer and

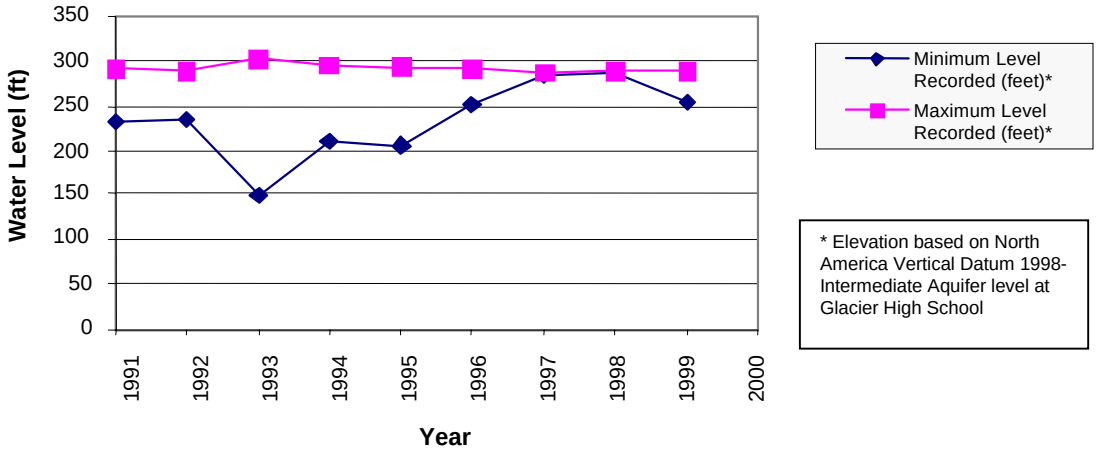
spreadsheet compatible files. The monitoring data loggers are programmed to read the aquifer level every four hours.

Aquifer Storage and Recovery has proven an effective means to augment natural recharge in the Highline Wellfield.

SPU uses monitoring well data in early spring each year to determine if the piezometric heads in the Intermediate Aquifer have returned to normal (full) levels. As stated previously, aquifer storage and recovery (ASR), also known as artificial recharge, has been proven to be an effective means to augment natural recharge in the Highline Wellfield. The Wellfield has had only sporadic use in the last several years, so ASR has not been needed. However, if the aquifer is slow in returning to the normal level, ASR can be applied. This action will effectively reduce or eliminate the threat of long-term declines in the aquifer water level.

The monitoring well on the grounds of the former Glacier High School is about midway between the pumping centers of Riverton and Boulevard wells. It is considered to be representative of overall piezometric head in the Intermediate Aquifer, which is the production aquifer for the Highline Wellfield. Exhibit 4-1 is a plot of water levels in this monitoring well from 1990 to 1999. As may be seen from the plot, no long-term change in the aquifer piezometer levels is observable.

Exhibit 4-1
Highline Wellfield Water Levels
(Monitoring Well at Former Glacier High School, Intermediate Aquifer)



4.4.4 Water Shortage Contingency Plan Update Summary

The Water Shortage Contingency Plan (WSCP) (Appendix 4-E) provides guidance to SPU during water shortages, particularly those relating to unusually dry conditions that occur in some years. The WSCP was last revised in 1993, subsequent to the area's last significant water shortage in 1992. That version was found to be effective and useful when there was concern about a potential shortage related to an El Nino event in 1998.

However, during that time, the WSCP was revisited and several interim changes were adopted. These were primarily refinements of procedures relating to any future lawn-watering ban.

The WSCP has been revised as part of the WSP process. The interim changes are included, as are certain other changes to bring the document up to date. Improved estimates of potential savings related to various curtailment measures that became available as a result of the 1992 water shortage are also included in this revised WSCP.

The plan is structured according to four stages:

1) Advisory
2) Voluntary
3) Mandatory
4) Emergency Curtailment

There is a section for each stage, which addresses water supply and other internal actions, communication actions, curtailment measures, etc. for that stage. The fourth stage, Emergency Curtailment, replaces the Rationing stage from the 1993 WSCP.

The Rationing approach for residential customers identified a consumption target for each household based on a per capita consumption amount. If this amount were exceeded during the billing period, a rate surcharge would be applied. Since the utility does not know how many people reside in each household, an average household size would have been assumed, with an exception process available for those with larger households (to enable them to receive a higher consumption target).

Because commercial uses of water are so variable, a somewhat different approach was used for commercial customers. During the Rationing stage, commercial customers would be asked to reduce their previous 12 months' consumption by a set amount, with a surcharge applied if this amount was exceeded.

Emergency curtailment relies on a combination of mandatory curtailment measures and rate surcharges to achieve very high levels of demand reduction. SPU staff estimates that this approach has the potential to reduce demands as much as the Rationing approach would. It is replacing Rationing for several reasons. The information needed to administer the Rationing approach is not available. Obtaining this information would require intensive effort and it would need to be updated continually as residents move, and households gain or lose members. Further, in the event the Rationing approach was implemented in the absence of this information, there would be an enormous administrative burden on both SPU staff and on the customer to process the exceptions to the average household estimate.

While much of the WSCP is designed around the concerns of a peak season drought, this revised WSCP also addresses water shortages due to other causes, including short-term supply disruptions, such as those associated with a major facility loss (e.g., a transmission pipeline).

4.5 Interties

This section describes the current status of existing and proposed interties. As defined in Chapter 246-290 WAC for Group A Public Water Systems, "intertie" means an interconnection between public water systems permitting the exchange or delivery of water between those systems. Information provided here has been drawn mainly from a submittal that was sent to Ecology by letter dated June 28, 1996, in compliance with State law (RCW 90.03.383). The information has been updated with the changes in status that have occurred subsequently. It should be noted that the definition of "intertie" in the state Water Code is different, and narrower, containing limiting language that appears to make the term inapplicable to interconnections used for the purpose of "development of new sources of supply to meet future demand" (See RCW 90.03.383(2)(a).) This WSP uses the term as it is defined in Chapter 246-290 WAC, unless otherwise noted.

4.5.1 Existing Interties

Information on interties was previously submitted to Ecology and DOH by letters dated June 28, 1996. It is in tabular format and is presented in the WSP in the same way.

Retail Service Interties. This category includes customers who maintain private systems that purchase water directly from SPU (Table 4-6). No formal written contract is in effect for these customers. Only three of these customers remain: The Highlands, Shorewood Water Association, and the Port of Seattle's Seattle-Tacoma International Airport. Included in the 1996 submittal were City of Renton, and the Boeing Renton plant. However Renton is now a contracted purveyor of SPU, and service to the Boeing Renton plant has been transferred to the City of Renton.

Interties Between SPU and its Contracted Purveyors. As the wholesaler of water to most of the developed parts of King County, SPU has "interties" with 27 contracted purveyors. Each purveyor has at least one tap, or service connection, that links the purveyor to the SPU transmission network. More often than not, the purveyors have multiple taps. For purposes of intertie reporting required by Ecology, each tap is classified as a separate intertie (Table 4-7). Meter sizes have been listed to provide a rough estimate of the hydraulic capacity, since the meter size dictates an acceptable operating flow range for the meter.

In 1982, Seattle's contracted purveyors signed a Water Purveyor Contract, either Version A or B. The language of both of the original contract versions is included in Appendices 4-F and 4-G (the 1994 First Amendment to the contracts deals with financial matters and is included as Appendix 4-H). Renton's contract, which was signed in 1997 and was modeled on the 1982 contracts, replaced water sales provisions in a 1931 pipeline street use permit. It is included in Appendix 4-I.

The current contracts (except Renton's) do not limit the purveyors in the amount of water that the purveyors may purchase from Seattle. During the peak season (June 1 through August 31), purveyors must control daily peaking flows to within 30 percent of the daily average consumption, or risk incurring a financial penalty called a "demand charge." The contracts do require that the purveyors participate in regional conservation efforts.

Interties Between Contracted Purveyors and Other Public Water Systems. With the approval of SPU, contracted purveyor water districts may enter into agreements with adjacent, non-contracted water purveyors, for the supply of water from Seattle's supply sources (Table 4-8). All proposals for new "interties" as that term is used in the Water Code, must also be approved by DOH and Ecology. Only these interties that allow for transfer of "SPU Water" to non-contracted purveyors are listed.

Table 4-6, 4-7, 4-8 not available online.

4.5.2 New Interties

Connection to SSP. The Second Supply Project would create an "intertie" within the meaning of the Department of Health regulations since connections will be made between TPU and SPU water systems, and TPU and other south King County utilities.

Under the Agreement, up to 40 MGD of water from Tacoma's Green River supply would be delivered to Seattle at Lake Youngs through the North Branch of the Second Supply Pipeline (formerly referred to as the Tacoma-Seattle Intertie Pipeline). There would be three points of delivery of Tacoma water into the Seattle system, any of which could be used under varying conditions. They include:

- At the abandoned headwall (old Cascade Dam) at the east side of Lake Youngs, or other discharge location to Lake Youngs;
- At the headworks of the proposed Cedar Treatment Facility (new ozone treatment plant); and
- At the clearwell for the proposed Cedar Treatment Facility (new ozone treatment plant) for delivery to Seattle's transmission system.

Delivery of water from Seattle to Tacoma is not contemplated by the Agreement and would not be possible unless pumps were installed.

Other Future Connections. As changes in their service areas occur, Seattle's contracted water purveyors occasionally request changes in service connections. These requested changes may call for the relocation or enlargement of an existing service connection, and sometimes the construction of a new service connection at a different location on the transmission system. The contracted purveyors are also required by the contract to include Seattle in the approval process for interties with the contracted purveyor and adjacent non-contracted purveyors. All significant revisions to service connections are done in consultation with the State regulating agencies. Changes known to be in process at this time (September 2000) are listed in Table 4-9

Table 4-9
Revisions in Existing Purveyor Service Connections

Wholesale District/City Name	Service Requested and Status (as of September 2000)
Water District 119	New tap on Tolt River Pipeline at the intersection of the pipeline easement and N.E. Big Rock Road. SPU has requested more detail on the proposed connection.
Water District 49	Remove 8" meter/service at 1st Ave. S. and S. 146th St. Replace 8" meter at Des Moines Wy S. and S. 168th St. Would re-activate an old purveyor tap; original ownership is being checked.
City of Bellevue - Utilities Services Division	Relocation of 10" Purveyor Meter; in final design, permits being obtained.
Highline Water District	Upgrade of Crestview Pump Station meter from 12" to 16"; construction pending.
Highline Water District	Replace 8" Purveyor Meter. Relocate to non-traffic location. This project is related to Des Moines Creek Bridge relocation project); in final design phase.
Mercer Island	Install new 10" meter on emergency intertie pipeline on Mercer Island; construction targeted for Fall 2000.
Redmond	Install new 10" meter with Tolt Tieline. Install unmetered service with Tolt tieline to be utilized in the future; meter has not been accepted by SPU Metering Division.
Renton	Relocate two 10" services to the Boeing Renton plant in the City of Renton; Renton has lead.
Shoreline Water District	New emergency intertie at 193rd St. & 1st Ave. N.E. (Richmond Highlands 590 zone)